Voyager-Jupiter Radio Science Data Papers

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The reduction and interpretation of the radio science data from the Voyager 1 and 2 encounters of the planet Jupiter and its satellites has resulted in the preparation of several papers for publication in the special Voyager-Jupiter issue of the Journal of Geophysical Research. *The radio science and tracking systems of the Deep Space Network provide the data which makes this research possible. This article lists submitted papers by title, with their authors and with abstracts of their contents.*

The Atmosphere of Jupiter: An Analysis of the Voyager Radio Occultation Measurements

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Coherently related S- (2.3 GHz) and X-band (8.4 GHz) signals transmitted from Voyagers 1 and 2 have been used to probe the Jovian atmosphere during occultations of the spacecraft by Jupiter. The observations have yielded profiles in height of the gas refractivity, molecular number density, pressure, temperature, and microwave absorption in the troposphere and stratosphere of Jupiter at altitudes ranging from 0° to about 70° south. The data cover a pressure range from 1000 to 1 mbar over a height interval of 160 km. At the 100 mbar level, the temperature was 165 ± 7 K and the temperature lapse rate was equal to the adiabatic lapse rate. The ammonia vapor abundance in this region of the atmosphere was about 0.015%, in approximate agreement with the value derived from cosmic abundance considerations. The tropopause, which was detected near the 140 mbar level, had a temperature of 100 K. Above the tropopause, the temperature increased with increasing altitude, reaching 160 ± 20 K in the 10 to 1 mbar region of the stratosphere. Significant horizontal density variations were detected in the stratosphere, which may imply a non-uniform temperature and aerosol distribution across the Jovian disk. The zenoid or gravity equipotential surface which best fits the 100 mbar isobaric surface has an equatorial radius of 71,541 ± 4 km and a polar radius of 66,896 ± 4 km. The data in this report was obtained from the narrowband open loop recordings (5 and 15 KHz at S- and X-band, respectively). A programmed local oscillator was used to keep the spacecraft signals within the chosen bandwidth.

Dispersive Doppler Measurement of the Electron Content of the Torus of Io

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As Voyager 1 made its swing-by of Io, it passed through the satellite's plasma torus. The phase of the coherent 13-cm and 3.6-cm wavelength signals transmitted from the spacecraft was accelerated by the propagation medium, which resulted in the observation of a dispersive doppler signature at the NASA/Jet Propulsion Laboratory Deep Space Network stations.

Ray path integration through three different models of the electron distribution of the torus of Io (Warwick, et al. (1979), Birmingham, et al. (1980), and Bagenal, et al. (1980)) have been performed. The results of the integrations are compared to the dispersive doppler data.

Radio Occultation of Jupiter's Ring: Bounds on Optical Depth and Particle Size

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The Jovian ring is not detectable in the radio occultation data, setting the bounds on its optical thickness of 2×10^{-4} and 5×10^{-4} at 13 and 3.6 cm wavelengths, respectively. Comparison of the results at the radio, infrared, and optical wavelengths suggests a population density that either falls more rapidly than the inverse square of the linear size or is sharply bounded in maximum particle size. A fragmentation power law of power index between -3 and -4 leads to a minimum size estimate of 1-2 μm.

A Search for the Radio Occultation Flash at Jupiter

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The "evolute flash," a focusing effect caused by the curvature of a planet's limb, was sought in the data from the Voyager 1 Jupiter encounter using a modified matched filter technique. The flash signal frequency structure is double-branched, here approximated by two quadratic functions, while the intensity structure is highly peaked in part due to the Voyager 1 geometry. The search for this signal was carried out over a 6.4 s period; the signal parameters were varied to span the uncertainties introduced by errors in the orbit determination and the shape of Jupiter. Several peaks of the order of 8σ above the mean are present in the filter output. However, these peaks were separated in time by up to 3.3 seconds, the multiplicity of which indicates the signal was not detected. A lower bound on the absorption along a ray with periapsis near 4.3 bar is 24 dB. Employing a locally isothermal atmospheric model, it is estimated that the flash will be visible if the distance behind the planet where the spacecraft trajectory crosses the evolute is approximately 20 Jupiter radii at a ray periapsis pressure of between 1 and 2 bar.

The signal search was made through the use of open loop pre-detection recordings of the spacecraft signal recorded by the Deep Space Network.

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